

Piston-Type Accumulator

The invention relates to a piston-type accumulator having an accumulator housing in the form of a cylindrical tube in which a separating piston, which separates two working chambers from each other, may be moved in the axial direction within a piston stroke area of the cylindrical tube which is closed off at both axial ends by a closing component, at least one of which closing components is configured by shaping of a reshaping area of the wall of the cylindrical tube adjoining the piston stroke area as an integral part of such wall.

Piston-type accumulators in the broadest sense of the term are in the category of so-called hydraulic accumulators, which perform the function of receiving specific volumes of a pressurized liquid (hydraulic medium) from a hydraulic system and returning these volumes to the system as required. Since the hydraulic medium is under pressure, hydraulic accumulators are treated as pressurized containers and must be designed for the maximum excess operating pressure, with allowance made for the acceptance standards of diverse countries in which the containers are installed. In most hydraulic systems use is currently made of hydropneumatic (gas-impinged) accumulators with separating elements, a piston which separates a fluid space as a working chamber from a gas supply space as another working chamber serving as the separating element inside the accumulator housing of the piston-type accumulator. As a rule nitrogen is used as the operating gas and the gas-tight piston to a great extent permits decoupling of gas supply space from liquid space.

The fluid component is connected to the hydraulic circulation, so that the piston-type accumulator receives fluid when the pressure rises and the gas is compressed in the process. The compressed gas expands as the pressure drops and forces the stored pressurized fluid back into the hydraulic circulation. It is an advantage of piston-type accumulators that they can Awork@ in any position, but preference is to be given to a vertical arrangement with the gas side on top so that settling of fouling particles from the fluid onto the piston seals is prevented.

The essential components of a piston-type accumulator thus are an outer cylindrical tube as accumulator housing, the piston with sealing system as separating element, and closing components on the front side which are both cover elements and at the same time also include a fluid connection and a gas connection. The accumulator is as a rule assigned two functions, that of supplying the interior pressure and that of ensuring control of the piston inside the accumulator housing.

In an effort to make production of hydraulic accumulators more efficient and cost-effective a transition has already been made to not providing a separate cover part as closing component fastened at least on the front end side of the cylindrical tube but rather to configuring the closing component as integral with the front end of the cylindrical tube, the wall of this tube being shaped in a reshaping area. WO 98/55258 discloses an appropriate example of the production of a hydraulic accumulator in the form of a diaphragm accumulator. Shaping of the closing component is effected by conventional means as a function of the type of material of the cylindrical tube by cold or hot working, for example, after flame or induction heating has been completed, by means of rolling or compressing, the end of the cylindrical tube being reshaped to a bottom with a collar turned outward on which a connection for the appropriate operating medium is formed. While the expenditure of production effort required for production of a

diaphragm accumulator is simplified, problems arise if such processes are to be carried out for production of piston-type accumulators.

On the basis of this state of the art the object of the invention is to create a piston-type accumulator the construction of which affords the possibility of simple and efficient production of the accumulator housing by shaping of the cylindrical tube on the end without generating problems during operation with respect to the behavior of a piston-type accumulator manufactured in this manner.

It is claimed for the invention that this object is attained in the case of a piston-type accumulator as indicated in the foregoing in that there is provided in the interior of the cylindrical tube, at the point of transition from the piston stroke area to the reshaping area, a stop element restricting the movement of the separating piston before reaching the reshaping area.

As a result of the restriction or blocking of the piston movement with the piston in an end position in which the piston is still outside the reshaping area, as claimed for the invention, the risk of interruption of operation is effectively prevented. If there were no piston end position specified for piston-type accumulators with a reshaping area provided on the end of the cylindrical tube, so that the separating piston could enter the reshaping area in certain operating situations, such as loss of gas in the gas supply space or high fluid pressures for example, the danger would exist of canting or seizing of the piston because of the possible change in the geometry of the piston during shaping of the wall of the cylindrical tube and roughened areas in the interior of the end of the housing due to the reshaping. The stop element mounted inside the cylindrical tube in such a position as claimed for the invention, in which the end position of the reshaping area is secured at the end of the piston thrust area and accordingly before entry into the reshaping area, makes certain that the trouble-free and gas-tight control of the piston afforded by

the interior wall of the cylindrical tube in the piston stroke area will be maintained under all piston operating conditions.

By preference the stop element is positively fitted so as to be secured from axial movement by retaining surfaces positioned on the inside of the wall of the cylindrical tube, so that definite limitation of the stroke of the piston is ensured even in the event of hard contact with the stop element.

A first retaining surface positioned at the end of the piston stroke area may be configured as a shoulder forming a recess in the inner wall of the cylindrical tube. The stop element may be introduced into the cylindrical tube from the adjacent open end and positioned on the shoulder before shaping during production of the piston-type accumulator. The stop element is now mounted in a specific position for the shaping step forming the closing component of the cylindrical tube. A second retaining surface positively locking the stop element, a surface positioned inside the reshaping area, may now be configured by shaping the wall of the cylindrical tube forming the closing component, the wall of the cylindrical tube being shaped during shaping around the wall area of the stop element situated in the reshaping area.

This "molding" of the stop element is found to be especially advantageous if the stop element is in the form of a level plate having on its circumference a crowned, convex camber around which the wall of the cylindrical tube is shaped during formation of the closing component in order to configure the second retaining surface situated in the reshaping area.

When use is made of a stop element in the form of a plate, that is, a rigid structural element situated in the cylindrical tube at the point of transition to the reshaping area, the additional advantage is gained that the stop element functions as a support element in the process

of shaping, so that the piston stroke area situated in advance of the circumferential area is supported during configuration of the closing component and accordingly is protected from any alteration of its geometry potentially caused by the shaping process.

Use of a plate-shaped stop element may be replaced by an annular element round in cross-section, such as a steel ring which is forced into a seat forming the positive-locking retaining surface, this seat being installed in the inner wall of the cylindrical tube.

The invention will be described below with reference to the exemplary embodiments illustrated in the drawing, in which

- FIG. 1 presents a simplified diagram of a detached longitudinal section of an exemplary embodiment of the piston-type accumulator claimed for the invention, of which only the end area of the accumulator housing on the gas side is shown, piston sealing and control means being omitted, and
- FIG. 2 a longitudinal section similar to that of FIG. 1 of a second exemplary embodiment.

In the case of the piston-type accumulators claimed for the invention and shown in the drawing the accumulator housing has a round cylindrical tube 1 which defines a longitudinal axis 3. In its end area the cylindrical tube 1 has on the gas side a closing component 7 delimiting a gas supply space 5, which component, as an integral part of the cylindrical tube 1, is formed by shaping the wall of the cylindrical tube 1 in a reshaping area 9. As has already been stated, the shaping process forming the closing component 7 has been carried out in accordance with a reshaping process disclosed in the prior art, a cold or hot working process being executed by

means of rolling or chasing tools or the like, as a function of the properties of the metal material making up the cylindrical tube 1, in order to configure the closing component 7 as a closed bottom on which is formed projecting coaxially to the axis 3 a neck component 11 on which are configured a gas channel 13 leading to the gas supply space 5 and a connection for appropriate connection fittings (not shown).

A separating piston 15 which forms the separating element between gas supply space 5 and a fluid space 6 has a trough-like recess 17 concentric with the longitudinal axis for increasing the volume of the gas supply space 5 and is controlled inside a piston stroke area 19 of the cylindrical tube 1 so as to be longitudinally displaceable. The inside of the wall of the cylindrical tube is microfinished in the piston stroke area 19 in order to ensure gas-tight and low-friction piston control inside the piston stroke area 19 in conjunction with piston closing and piston control means provided on the circumference of the piston 15. The sealing and control means provided on the circumference of the piston 15 are not shown in the drawing. These means, seated in circumferential annular grooves 21 of the piston 15, may be of conventional design.

At the end of the piston stroke area 19 there is in the inner wall of the cylindrical tube 1 a shoulder 23 forming a recess in the inner wall. This shoulder makes available a level stop surface for a level plate 25 for the fixing of which in position it forms a retaining surface which locks the plate 25 positively against axial movement in the direction of the piston stroke area 19. The plate 25 has a convex, crowned circumferential surface 27. During shaping of the wall of the cylindrical tube 1, in which the reshaping area 9 adjoining the piston stroke area 19 is formed, the wall of the cylindrical tube 1 is shaped around the crowned circumferential surface 27 of the plate 25, so that the shaped cylinder wall forms a second retaining surface on the

crowned circumferential surface 27 for fixing the plate 25 in position so that the latter is secured positively against axial movement in both directions.

In the process of production of the hydraulic accumulator the plate 25 is introduced from the initially open end of the cylindrical tube and positioned against the shoulder 23 so that it accordingly is suitably positioned for the shaping step. As additional fixing in position, in advance of execution of the shaping step forming the reshaping area 9 the recess 23 forming the shoulder 23 in the inner wall of the cylindrical tube 1 may be configured so that the bottom of the recess forms in conjunction with the crowned circumferential surface 27 of the plate 25 a press fit which holds the plate 25 in position during shaping of the circumferential area 9.

An opening 29 configured centrally in the plate is provided as gas discharge opening. The plate 25, designed as a relatively rigid structural element of a steel material, for example, forms not only a stop element for the piston 15 which blocks movement of this piston before leaving the piston stroke area 19 but additionally forms a rigid support element for the cylindrical tube 1 in the area of transition from the piston stroke area 19 to the reshaping area 9 during the shaping process, in such a way that the shaping forces acting on the reshaping area 9 can cause no changes in the geometry of the cylindrical tube 1 in the piston stroke area 19. The piston 15 is accordingly controlled in the microfinished piston stroke area 19 under all operating conditions of the piston-type accumulator, the plate 25 acting as stop element making certain that no introduction of the piston 15 into the reshaping area 9 may occur, while the inner wall of the cylindrical tube 1, unlike piston stroke area 19 extending to the shoulder 23, requires no microfinishing on the inside.

The exemplary embodiment shown in FIG. 2 differs from the example shown in FIG. 1 only to the extent that the stop element limiting piston movement at the end of the piston stroke

area 19 of the cylindrical tube 1 is a steel ring 31 rather than a plate. In this exemplary embodiment the shoulder 23 on the inside of the cylindrical tube 1 forms at the end of the piston stroke area 19 a cambered partial surface of a cambered inner annular groove 33 which forms the seat for the steel ring 31. The cambered surface of this annular groove 33, which extends around an adequate circumferential area of the steel ring 31, forms the retaining surfaces positively locking the ring 31 from axial movement in both directions.

A closed ring 31 may be used if the annular groove 33 is configured exclusively by the shaping which forms the reshaping area 9 in the area axially some distance from the shoulder 23, so that the steel ring 31 may be introduced from the open end of the cylindrical tube 1 in advance of shaping. As an alternative, that is, if the annular groove is not finished in the shaping process, that is, so to speak as closed, a slotted steel ring 31 may be forced into an already fully configured annular groove 33.

In the example shown in FIG. 1 a plate 25 with only one opening 29 for gas discharge opening is shown. It is obvious that a plate having several openings, including one in the form of a mesh plate, could be provided.